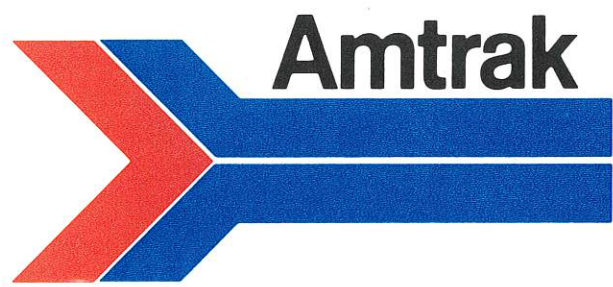
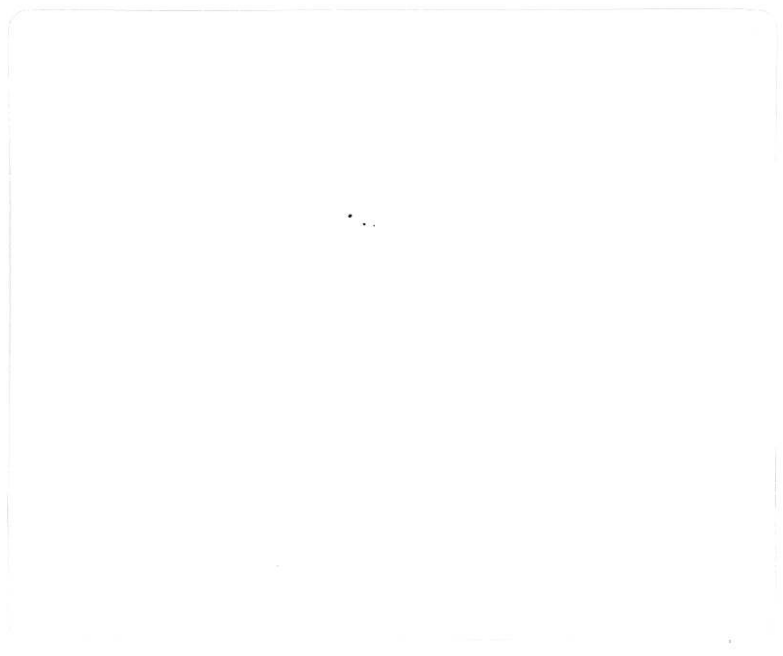
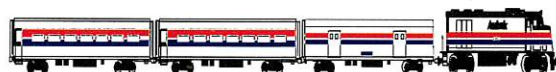


NATIONAL RAILROAD PASSENGER CORPORATION



THE ART OF SCHEDULING TRAINS



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**National Railroad Passenger Corporation
September 25, 1995**

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This paper on the Art of Scheduling Trains is the result of a viewgraph presentation to the American Association of Private Railroad Car Owners in Nelson, B.C., September 6, 1995, and The Lexington Group in Transportation History at Portland, OR, September 28, 1995.

It is designed to be an overview of the numerous factors considered in the development of passenger train schedules.

J. L. Larson
Washington, D.C.
September 19, 1995

Background

Scheduling trains is truly an art. Too much time in the schedule, the train will run late. Not enough time in the schedule, the train will run late, and with the right amount of time in the schedule, the train may still run late depending upon delays.

Late trains have been the point of jokes, cartoons and writings probably back to the earliest trains.

You may recall an old book named "On A Slow Train Through Arkansas."¹ One story related to a woman asking the Conductor why the train was stopped and he replied, "There are some cows on the track." Sometime later the train stopped again and the lady asked the Conductor why they were stopped. He replied, "We caught up to those cows again!"

Even though Amtrak is continually criticized in the media, the fact still remains that 9 out of 10 metroliners arrive on time, 8 out of 10 corridor trains arrive on time, and 7 out of 10 trains overall arrive on time.

Scheduling trains goes back to 1830. Illustration 1 is a copy of the oldest operating timetable in my files -- 1849. The table is for the New York and Erie Railroad between Port

¹ Thomas W. Jackson (d. 1934), On A Slow Train Through Arkansas (sic), Thomas W. Jackson Publisher, 1903.

Jervis and Owego, New York. The bold times show where trains were to meet or pass, but this predated train dispatching as we know it today (Illustration 1).

Occ. 30th JULY, 1849.

EASTWARD TRAINS. Owego to Port Jervis.				NAMES OF DEPOTS, STATIONS AND PASSING PLACES.	WESTWARD TRAINS, Port Jervis to Owego.			
FREIGHT TRAINS.		PASSENGER TRAINS.			PASSENGER TRAINS.		FREIGHT TRAINS.	
Night.	Day.	Night.	Day.		Day.	Night.	Day.	Night.
Cattle, &c.					Leaves After'n	Leaves Evening.	Leaves Morn'g.	Leaves After'n.
A. M.	P. M.	A. M.	P. M.					
7 05	10 18	2 50	1 27 ^r	Port Jervis.	1 28 ^r	10 50	5 45	4 00
6 25	9 38	2 22	12 50	Stairwaybrook. ²⁻³	1 55	11 10	6 25	4 30 ^a
6 10	9 23	2 13	12 50	Pond Eddy. ³⁻⁴	2 04	11 29	6 48	4 54
5 32	8 41	1 47	12 24	Barryville. ⁷⁻⁴ Chohola	2 29	11 56	7 30	5 34
5 12	8 15	1 32	12 09	Lackawaxen.* ⁴	2 44	12 12	8 00	6 00
4 40	7 40	1 16	11 53	Mast Hope. ⁵⁻⁴	2 58	12 28	8 38	6 30
4 10	7 10	12 58 ^r	11 38	Narrowsburg.* ⁵⁻⁶	3 20	12 58 ^r	9 18	7 10
3 20	6 00	12 22	11 05	Cochecton.* ⁸⁻⁴	3 43	1 27	10 05	8 10
2 48	5 17	12 06	10 50	Calicoon.* ⁵⁻³	4 01	1 48	10 50 ^r	8 50
2 13 ^r	4 23 ^r	11 42	10 28	Hankins.* ⁷	4 23	2 13	11 38	9 45
1 18	3 14	11 08	10 02	Equinunk. ¹⁰⁻³	4 51	2 43	12 41.	11 08 ^r
12 46	2 33	10 52	9 46	Stockport. ¹¹⁻³	5 11	3 05	1 23	11 48
12 22	2 00	10 37	9 31	Chehocton.* ¹²⁻⁴	5 28	3 21	2 00	12 22
11 18	12 48	10 01	8 55	Deposit. ¹³⁻¹	6 10	4 13	3 18	1 47
10 19	11 38	9 29	8 27	Gulf Summit.* ¹⁴⁻³	6 33	4 40	4 14	2 26
9 39	10 58	9 00	8 00	Lanesboro'.* ¹⁵⁻¹	7 05	5 13	5 30	3 26
8 50 ^{†r}	10 05	8 34 [†]	7 35	Great Bend. ¹⁶⁻³	7 28	5 37	6 18	4 19
7 48 ^{cdr}	9 12	8 12	7 12	Windsor.* ¹⁷⁻³	7 48 ^d	5 59	7 00 ^c	5 21
6 32	8 46	8 00 ^r	7 00 ^b	Binghamton.* ¹⁸⁻³	8 01 ^r	6 12 ^a	8 01 ^r	7 00 ^{abr}
5 28	7 45	7 36	6 36 ^r	Union.* ¹⁹⁻⁷	8 24	6 36 ^r	9 00	7 45
4 53	6 54 ^r	7 19	6 19	Campville.* ²⁰⁻³	8 41	6 54	9 40	8 28
4 15	6 02	7 00	6 00	Owego. ²¹⁻¹	9 00	7 13	10 20	9 10
Leaves After'n.	Leaves Morn'g.	Leaves Evening.	Leaves Morn'g.		P. M.	A. M.	P. M.	A. M.

See the Note on the other side and particularly the clause, marked "Night Freight Trains."

The fascinating instruction is on the reverse of this timetable.

Illustration 2 shows the special instructions in effect -- before the days of dispatching.

N. B. No Trains will be allowed under any circumstances to leave a station before the time specified in this Table, as regulated by the clock at the Piermont office.

The large figures show the points of meeting of Trains. The letter P is added where the expected train is a passenger train.

All Passenger Trains going East are entitled to the road. Passenger Trains going West, will keep out of the way of the Eastern Passenger Trains.—See 2d clause of Instructions.

When engines are transferred from one principal station to another, they shall follow one of the times of this Table and be subject like Extra Trains to the directions given in the 17th and 19th clauses of the Instructions.

In regard to Gravel and Wood Trains see the 12th clause of the Instructions.

Enginemen of the Night Passenger Trains are reminded, that sufficient time is given in this Table, to enable them to run the road safely and cautiously. All enginemen will work up their available time on the road, reporting occasionally to their Superintendent, where their experience shows, that the time given, does not conform to the business of the road. Enginemen will not put any branches or decorations on their engines, which can in any way interfere with the regular signals.

Night Freight Trains.—The Night Freight Train from Port Jarvis moving Westward—passes the Night Passenger Train at Binghamton at 6 12a, and remains at Binghamton until the Morning Passenger Train passes, whose time is 7 00b. The Night Freight Train from Owego, leaving at 4 15 P. M., must make the Windsor road by 7 P. M.—the Day Freight Train passing it there at 7 00c. It waits there until the Day Passenger Train Passes Westward, whose time is 7 48d. The Night Freight Train from Owego must also reach Great Bend by 8 34 to allow the Night Passenger Train to pass there whose time is 8 34 P. M.

The Night Freight Trains until further notice will leave Owego on Mondays, Wednesdays and Fridays, and will leave Port Jarvis for Owego on Tuesdays, Thursdays and Saturdays; they will only be put on when necessary, and then notice will be given. A white flag will be carried on the engine of the Day Freight Train, when a Night Freight Train is to be on the road. The Night Freight Trains will keep out of the way of all Day Freight Trains, as well as of all the Passenger Trains.

The Night Passenger Trains stop twelve minutes at Narrowsburg, and six to eight minutes at Deposit. The Day Passenger Trains will always stop the allowed time at Port Jarvis—and they will stop five minutes at Narrowsburg when not behind time.

Night Freight Trains -- The Night Freight Train from Port Jervis moving Westward -- passes the Night Passenger Train at Binghamton at 6:12, and remains at Binghamton until the Morning Passenger Train passes, whose time is 7:00. The Night Freight Train from Owego, leaving at 4:15 P.M., must make the Windsor road by 7:00 P.M., -- the Day Freight Train passing it there at 7:00. It waits there until the Day Passenger Train Passes Westward, whose time is 7:48. The Night Freight Train from Owego must also reach Great Bend by 8:34 to allow the Night Passenger Train to pass there whose time is 8:34 P.M.

Can you imagine the difficulty in getting trains over the road under these conditions? With no provisions for adjusting for late trains this operation had to be bad.

In 1851, Charles Minot was superintendent of the Erie Railroad. Impatient at the delay waiting for an opposing train, he wired the telegrapher at Goshen to hold opposing trains and then gave a written order to the crew to proceed. The engineer refused so Superintendent Minot ran the engine. He repeated the process until the train arrived at Port Jervis.

Superintendent Minot gave the first train orders by telegraph, a procedure that remained in effect for over 100 years.

Illustrations 3 and 4 are examples of train orders from Baraboo, Wisconsin dating from 1881.

W F Beecroft & Eng'r May 14
Baraboo

Run to Madison
Keeping out the way all
regular trains looking out
for wild trains ahead of
you. Do not pass Lodi
without further orders
JHH

(1) "W. F. Beecroft and Engineer -- Run to Madison, keeping out the way all regular trains, looking out for wild trains ahead of you. Do not pass Lodi without further orders. Answer: JHH."

13-ara 000 13-
 W. F. Beecroft Eng
 Do not leave until
 J. Ingraham
 wild train
 bound south
 arrives. and
 JHH

W. F. Beecroft Eng
 12³¹ PM All Right
 JHH

(2) "W. F. Beecroft and Engineer -- Do not leave Brooklyn until J. Ingraham
 wild train bound south arrives. Answer: JHH."

Primitive in form perhaps, but the system worked. A wild train was what we
 know as an extra train today. By 1889 or 1890, the operating timetable became a

complicated work of art due to the sheer volume of trains and the large number of meets and passes that occurred.

Illustration 5 shows a small excerpt from the Chicago & North Western Iowa Division operating timetable of 1889. Note the passenger train names -- "Denver Limited", "Pacific Express", "Atlantic Express", etc.

C + NW Ry. IOWA Division Timetable No. 122 July 7, 1889

PASSENGER TRAINS.				STATIONS.	Distance from Chicago.	PASSENGER TRAINS.				14 Spokane and Clifton Accommodation.	28 Falls Palace Way Freight.
13 Clifton and Boone Accommodation.	7 Denver Limited.	5 Pacific Express.	3 Omaha Express.			4 Atlantic Express.	6 Chicago Express.	8 Denver Limited.			
.....	1.30 P. M.	10.30 P. M.	12.01 P. M.	Dep. Chicago	Arr.	12.00 M.	6.00 A. M.	7.00 A. M.	6.15 A. M.	6.15 A. M.	
N. Sunday.	Daily	Daily	Daily	Dep. Chicago	Arr.	Daily	Daily	Daily	Ex. Sunday.	Ex. Sunday	
8.55 AM M16	9.55 PM M12	9.40 AM	8.15 PM	Dep. Chicago	Arr.	7.53 AM M1 35	1.25 AM	2.37 AM	8.00 PM	6.25 PM M15	
7.00 M1 30	10.00	9.40	8.32	2.0	Stock Yards	7.48	1.10	2.30 M1 20	8.50	8.15	
7.15	10.05 M1 25	9.38	8.37	2.5	Camanche	7.53	1.10	2.33	8.45	8.05	
7.35 M1 4	10.14	9.48	8.37 M1 20	3.0	Low Moor	7.58	1.00	2.10	8.30	5.37 M1 3	
7.50	10.22	9.48	8.47	3.5	Malone	8.03	12.50	2.07	8.17	5.10	
8.05	10.33	9.52	8.00	4.0	De Witt	8.08	12.40	1.08	8.00 M1 15	4.45	
8.23	10.40	9.58	8.15 M1 30	4.5	Grand Mount	8.13	12.30	1.47	7.40	4.20	
8.41	10.48	10.00 M1 30	8.20	5.0	Calamus	8.18	12.14	1.37	7.24	3.80	
8.59	11.04	10.10	8.40	5.5	Wheatland	8.23	12.00 AM	1.30	7.12	3.25	
9.11	11.13	10.22 M1 22	8.52 M1 14	6.0	Lowden	8.28	11.00 PM	1.10	6.55 M1 3	3.00	
9.40	11.27 M1 6	10.30	9.00	6.5	Clarence	8.33	11.27 M1 7	1.07	6.08	2.30	
10.00	11.37	10.38	9.05	7.0	Stanwood	8.38	11.13	12.57	6.45	2.05 M1 37	
10.20 M1 10	11.42	10.45	9.10	7.5	Mechanicsville	8.43	10.55 M1 15	12.43	6.10	1.45 M1 29	
10.44	11.51 AM	10.50	9.15	8.0	Libon	8.48	10.39	12.30	6.55	1.15	
10.50	12.04	10.58	9.25	8.5	Mt. Vernon	8.53	10.34	12.28	6.50	12.55 M1 35	
11.13	12.15 M1 10 AM	11.05	9.40	9.0	Britann	8.58	10.14	12.15	6.25	12.15 PM M1 34	
11.30 M1 20	12.22 M1 30	11.10	9.45	9.5	Otis	9.03	10.03	12.05 PM 30 AM	6.10 M1 37	11.30 AM M1 19	
11.50	12.30	11.20	9.50	10.0	East Rapids	9.08	9.50	11.50 PM	6.00 M1 20	11.15	
12.05 PM	12.40	11.35 M1 10	9.52	10.5	Cedar Rapids	9.13	9.40	11.55	5.55	11.00	
12.15	12.45	11.40	9.57	11.0	West Rapids	9.18	9.35	11.40	5.37	10.40	
12.37	12.53	11.50	9.47	11.5	Beatty	9.23	9.18	11.30	5.15	10.20	
12.57 M1 30	12.58	11.55	9.53	12.0	Fairfax	9.28	9.10	11.25	5.05	10.12	
13.08	1.00 PM 15	12.55 M1 25	9.57 M1 6	12.5	Norway	9.33	9.07 M1 5	11.22	4.45 M1 21	9.48 M1 27	
1.13	1.15 M1 22	1.04	10.15 M1 16	13.0	Waukegan	9.38	8.54	11.10	4.25	9.00	
1.30	1.24	1.15 M1 20	10.20	13.5	Blainetown	9.43	8.42	11.05	4.05 M1 21	8.30 M1 25	
1.45 M1 11	1.33	1.25	10.25 M1 30	14.0	Louisa	9.48	8.30 PM 15	10.58	3.45 M1 13	7.40	
2.00 PM	1.42 AM	1.30 AM	10.31 PM	14.5	Arr. Belle Plaine	9.53	8.17 PM	10.50 PM	3.30 PM	7.15 AM	
Ex. Sunday.	Daily	Daily	Daily			Daily	Daily	Daily	Ex. Sunday.	Ex. Sunday	

Passenger train scheduling probably reached its most precise form in the late +30's, 40's and 50's when 90 and 100 mph speeds were not uncommon and absolute priority reigned.

Illustration 6 shows a New York Central timetable page from the Hudson River line in 1950. Note the unusual, if not unique procedure, of scheduling the operating timetable to the half-minute.

CROTON-ON-HUDSON to ALBANY											
Continued from page 10											
WESTWARD—FIRST CLASS											
Mile from New York		157 See Note	63 See Note	195 See Note	191 See Note	67 See Note	153	111 See Note	25	17	19
		Poughkeepsie	Albany	Poughkeepsie	Poughkeepsie	The Catskill Tunnel	Poughkeepsie	Poughkeepsie	Tenmile Crest Limited	The Watkins Line	Lake Shore Limited
	LEAVE	Daily except Sat. and Sun.	Daily	Daily except Sunday	Daily except Sat. and Sun.	Daily	Daily except Sat. and Sun.	Daily except Sat. and Sun.	Daily	Daily	Daily
		P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.
	Grand Cen. Term.	4.58	5.01	5.07	5.25	5.31	5.44	5.59	6.01	6.11	6.16
23.68	Croton-on-Hud.	5.49	5.56	5.56	6.22	6.27	6.42	6.47	6.55	7.04	7.12
35.68	Oscawana						6.45	6.55			
36.66	Cruisers	5.54		6.13	6.27		6.49	7.00			
38.10	Montrose						6.54	7.08	7.03	7.12	7.20
40.60	Pekskill	5.58	6.04	6.17	6.31	6.37					
45.36	Manitou	6.05		6.25			7.02	P. M.			
49.13	Garrison	6.11		6.32	6.44		7.10		7.13		
51.83	Cold Spring	6.16		6.37	6.48		7.16				
56.53	Dutchess	6.22	6.19	6.44	6.54		7.22				
58.29	Beacon	6.26	6.22	6.47	6.58		7.25				7.39
61.79	Chelsea	6.32		6.54			7.32				
64.38	New Hamburg	6.38		7.00	7.07		7.38			7.36	7.48
67.51	Camelot	6.43	6.32	7.05	7.10		7.43				
72.82	Poughkeepsie	6.50		7.12	7.18		7.51			7.42	7.56
	Poughkeepsie	P. M.	6.40	P. M.	P. M.		P. M.				
78.54	Hyde Park		6.50								8.06
82.94	Staatsburg		6.57								8.10
88.42	Rhinecliff		7.04			7.23			7.51	8.00	8.16
93.96	Barrytown										
98.26	Tivoli										
103.63	Germantown		7.14								
105.38	No. Germantown										
113.73	Hudson		7.24			7.38			8.07	8.16	8.35
117.98	Stockport										
121.17	Newton Hook		7.35			7.48			8.16	8.25	8.44
123.54	Stuyvesant										
129.64	Schodack L'dg.										
133.66	Castleton-on-Hud.										
141.61	Rensselaer		7.51			8.03			8.33	8.41	9.01
142.19	Albany		7.55			8.03			8.37	8.44	9.05
148.56	Troy										
	ARRIVE	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.	P. M.
Nos. 63, 195, 191, 67, 111 and 193 will not carry baggage. No. 67 will not run November 23, December 23, 24, 30 and 31, 1950. Nos. 195 and 191 will not run November 23, December 23, 1950, January 1 and February 22, 1951. Time shown at Grand Central Terminal is for information only.											
Hudson Division - Sept. 24, 1950											

Absolute priority is also a procedure from the past that is now largely forgotten. The clue to absolute priority was a line in the operating timetable such as "No. 1 and No. 2 are superior to all trains" or "All trains must clear Trains Nos. 400 and 401 by not less than 15 minutes." -- failure to observe these requirements often brought swift and severe discipline or at least an invitation to the superintendent's office to explain one's transgressions.

These instructions were generally reserved for the premier trains on each carrier such as the Twentieth Century Limited, the Broadway Limited, the Southern Crescent, the Sunset Limited, the Hiawathas, the "400's", the City trains, the Empire Builder, the Super Chief and the list goes on.

Today, the only trains in the country that enjoy absolute priority are Amtrak's Metroliners between Washington and New York and, I suspect, a handful of freight trains like the Blue Streak Merchandise or Santa Fe's No. 199.

That historical background brings us to our scheduling today which in some ways is quite similar to historical scheduling and in some ways quite different.

The Art of Scheduling Trains

Scheduling has three basic components.

-
- Pure Running Time
 - Dwell Time
 - Recovery Time

Pure Running Time

Is based upon running time developed at maximum authorized speeds, without delays, on a predetermined power to weight ratio.



What is the power to weight ratio? It is the relationship of locomotive horsepower to trailing tonnage. It is a critical factor in scheduling trains.

There are three ways of determining PRT:

1. Field Riding Program
2. Manual Desk Calculation
3. Computerized Train Performance Calculation

What is amazing is that regardless of the methodology used, the end results are very close -- generally within one or two percent.

The field riding program is often performed by a joint Amtrak-Railroad team who ride the engine over the entire trip, factor out delays, and measure running times and dwell times to the nearest tenth of a minute.

The manual desk calculation can be performed by only a handful of people in the U.S. who can manually calculate performance including acceleration, braking, curve speeds and other restrictions also to the nearest tenth of a minute.

Finally, TPC programs allow the computer to calculate performance over a line of railroad with amazing accuracy.

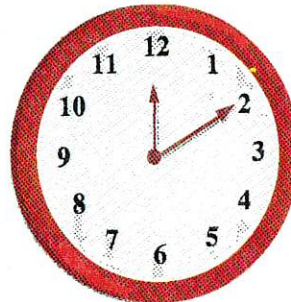
Dwell Time is the amount of time a train requires to perform its station work.

Smaller stations generally require 3 minutes or less, as does a crew change. Larger stations require more depending upon train and locomotive servicing, mail, baggage & express.



Recovery Time

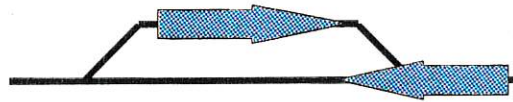
- Recovery time is time added to the schedule, generally 6% to 8%, to compensate for all contingencies (delays) encountered enroute. It may be as much as 3 hours per trip between Chicago and the West Coast.



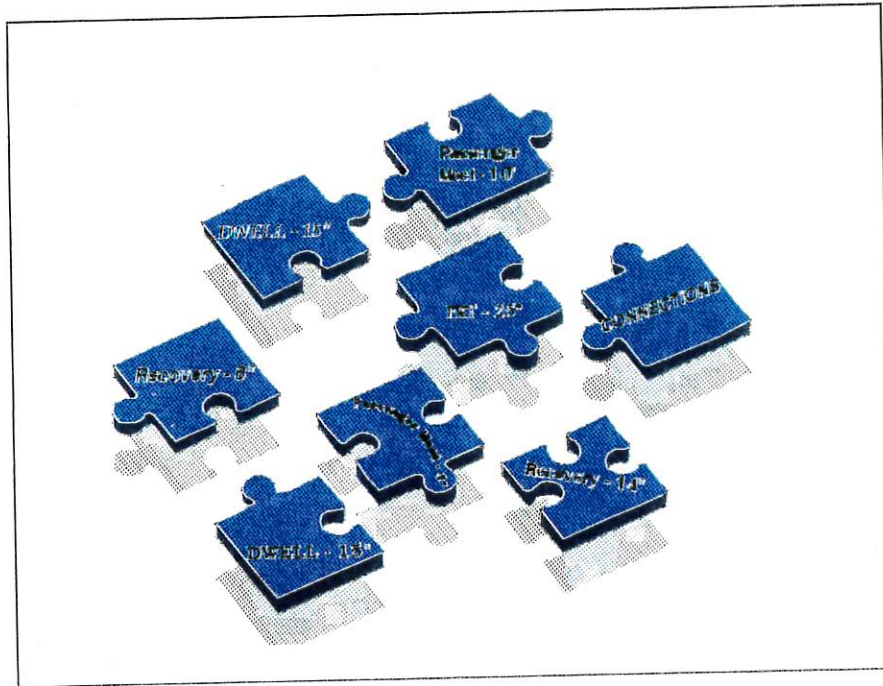
Recovery time by any other name -- fat, rubber, pad, etc. -- is still recovery time.

Passenger Train Meets

When passenger train meets occur on single track, we factor time into the schedule to accomodate these meets.



Now that we have all these bits and pieces of information, what do we do with it? The analogy of putting together a jigsaw puzzle is very close to the task of developing a schedule.



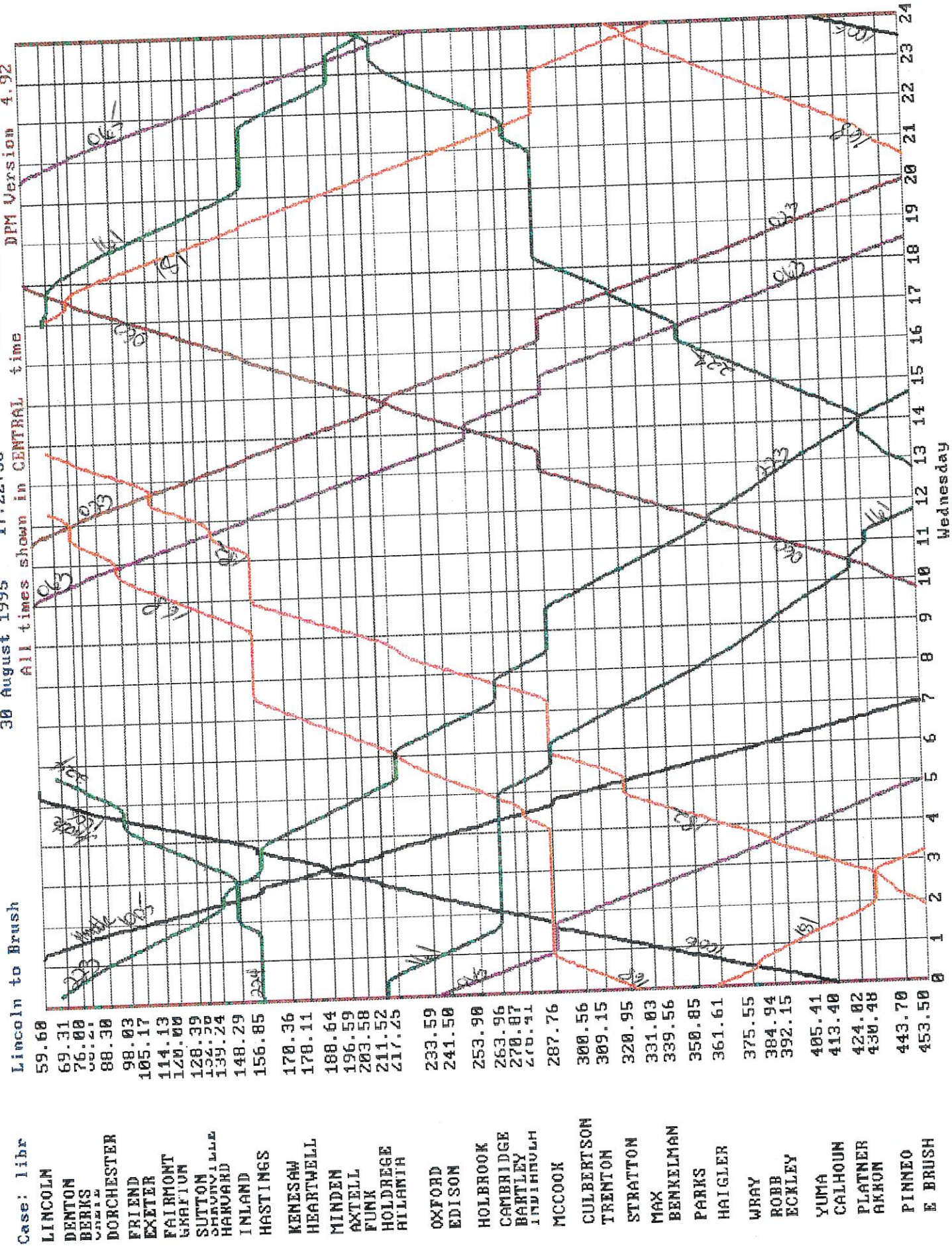
The critical skill is stringing the schedule. Stringing the schedule means putting the time together in a meaningful way that permits the train to operate, generally without killing time and yet reasonably close to on-time. This is the art of scheduling.

Once we have the strung schedule we need to prepare a string graph. A string graph has time on one axis and stations on the other axis and is a graph of the operation. Some countries, such as Japan, use string graphs as their official timetable.

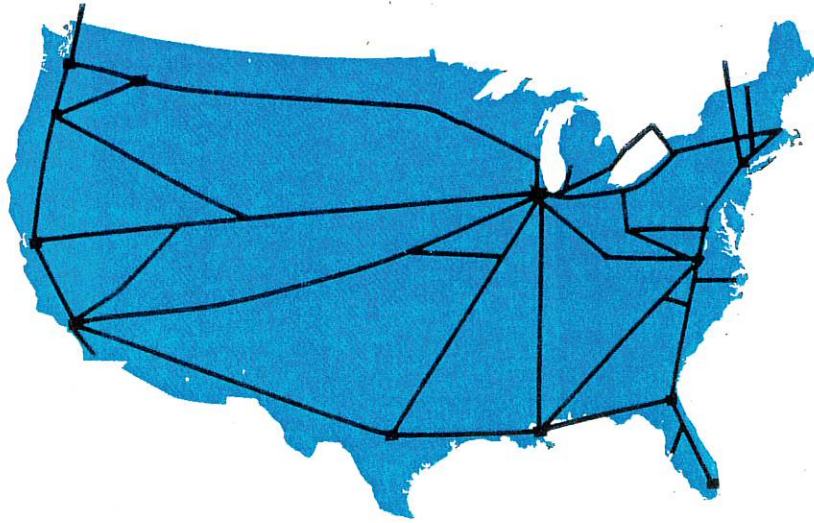
The term "string graph" comes from a large panel used over 100 years ago to graph the trains with yarn. As late as 1963 we used yarn at Green Bay to string the timetable. The original intent of a string graph was to avoid cornfield meets. Today we use it to determine if there is a siding available for the meets and to avoid congestion points.

When lines cross on a string graph it is a meet between opposing trains or two trains passing.

With modern day technology, computers are capable of preparing complicated string graphs. This procedure is currently used throughout the industry. Although there are a number of different systems in use, Amtrak uses PROTIM which is a series of programs and databases developed by British Rail Business Systems about five years ago. This system has the capability of developing schedules, station reports and string graphs with extreme accuracy. It is in use on Amtrak's Northeast Corridor where some segments handle over 300 trains each weekday. Illustration 7 is a computer generated string graph for the Burlington Northern between Lincoln, NE and Brush, CO.



CONNECTIVITY



The final test is connectivity. Amtrak's entire system is a grid with connections generating a significant portion of the revenue. Some trains may have 80 to 100 passengers connecting to another train. There are many connecting points, but Chicago is the real hub of the Amtrak system. Sometimes a 15-minute adjustment in one schedule will require a similar adjustment in a connecting schedule.

Now, are we ready to go to press? No, now we are ready to negotiate with the railroads.

Negotiations

Many people do not realize that Amtrak's schedules are negotiated with the railroads over which Amtrak trains operate. When Amtrak inherited the passenger train schedules in the early 1970's, some schedules were good, some schedules were bad and some overall were okay but needed restringing. Starting in 1976, Amtrak made a concerted effort to bring reasonable uniformity to the schedules in use throughout the system but this is an ongoing project that demands time and bodies to stay in tune with operational changes.

Railroads are sensitive to schedules for two reasons: (1) they do not want passenger trains to interfere with their primary freight operations and (2) on-time performance may drive millions of dollars in incentive payments. Both the length of schedules and schedule times are negotiated.

When a carrier responds, "My God, you can't be at Ajax at 8:30, why LABRF, No. 199, the Madame X and the Night Crawler are all there at the same time!", it's back to the drawing board. If they say in a nice way, "We would really like to accommodate No. 87 and your schedules but....", it's still back to the drawing board.

Another critical factor is scheduling commuter trains and intercity passenger trains so conflicts are minimal. This is called slotting trains. Commuter trains and intercity trains may operate on three minute headways and passing locations are critical

between express trains and local trains making all stops. In like manner, meeting opposing commuter trains is also a critical element.

Once the railroads and Amtrak agree upon schedules and running times it is time to go to the printers before someone changes their mind.

Delays

Now with all this work why don't trains run on time? Well, we have not addressed delays. Some delays are covered by recovery time, some are not. The causes of delays could fall into thousands of causal categories which we have condensed into ten plus "miscellaneous" which is a catch all.

When the amount of delay exceeds the available recovery time the train is late.

Some delays are considered
under Amtrak's control such as:

- Mechanical failures
- Servicing delays
- Passenger related delays



Some delays are considered under the freight railroads' controls

- Freight train interference
- Signal failures
- Maintenance of way/Slow order delays

The frequency of signal delays closely follows freight train interference and is often the result of the signals working as intended because of a train ahead as opposed to a signal failure.

Maintenance-of-way/Slow order delays are a very significant delay factor and fall into two major categories.

The first is slow orders because of deteriorating track.

The second is slow orders or work orders because of improving track conditions. Modern maintenance practices with production gangs frequently require taking the track out of service or require slow orders and lookout orders which impact upon performance.

Currently we are considering seasonal schedule changes that would compensate for delays incurred in major maintenance programs.

Some delays are beyond the control of either organization

- Firehoses over the tracks
- Snowslides, rockslides
- Heat orders, cold orders
- Grade crossing accidents
- 1,000 other things



Some of the more bizarre delays we have experienced include striking and killing a buffalo in North Dakota, a World War II landmine washing up on the shore of Puget Sound, and extracting an obese passenger from the toilet of the Broadway Limited. This has been a recurring delay on other trains as well, but not enough to create its own delay category.

Another category of delay includes meeting passenger trains.

- Freight railroads charge these delays against Amtrak
- Amtrak charges these delays against the railroad.
 - Dispatching is performed by the railroad
 - Time is allowed in the schedules for the meets



Freight railroad causal factors generally account for 40 to 50 percent of the total delays -- while Amtrak-related delays generally account for 20 to 30 percent and all other delays for the remaining 20 to 30 percent.

Out of slot -- a myth or for real?

There is a longstanding disagreement within the industry of the impact of a train being out of slot. The theory is that a train on time is easier to keep on time than it is for a late train to avoid becoming later.

I think all railroad field managers will agree that the out of slot theory held true on time table and train order territory and probably remains true to a limited extent in traffic control system (TCS) territory. The disagreement is over the magnitude of delay that results from being out of slot in TCS territory.

For example, just being late in TCS territory may move the meet from one controlled siding to another without material impact. It should be kept in mind that scheduled freight trains adhering to their schedules is also a significant variable. Passenger train meets at other than the programmed siding are likely to have a negative impact upon one or both trains.

There are other out of slot factors that do have a direct impact upon a train getting later without regard to TCS territory -- for example, commuter trains where a late train may take multiple hits or maintenance of way work or programmed work which would have been avoided if the train had been on time. Heat orders would also have a similar impact as would opposing or following fleets of freight trains.

Conversely a late train might also avoid the above delays by virtue of the fact that it is late, so the impact of being late cuts both ways.

Currently we are doing studies to determine if this is for real or a myth. Based upon our initial study covering over 400 long distance trains on six carriers and over 430,000 train miles there is no difference in time lost.

Dispatching - which train gets preference?

- No. 199 with the hot intermodal trailers and containers
 - LABRF with their hot manifest
 - Madame X - the division cleanup train
 - The Night Crawler - a puller handling empty camp cars
 - The Dogpatch Local - with two empty cars for the mill
 - Yard engine - going to the beanery to eat or switching the car repair tracks
 - All of the above
- OR
- The passenger trains



What it all boils down to is the quality of the train dispatching. The train dispatcher generally responds to the policies established by senior management. Which train gets the priority is the railroad's call.

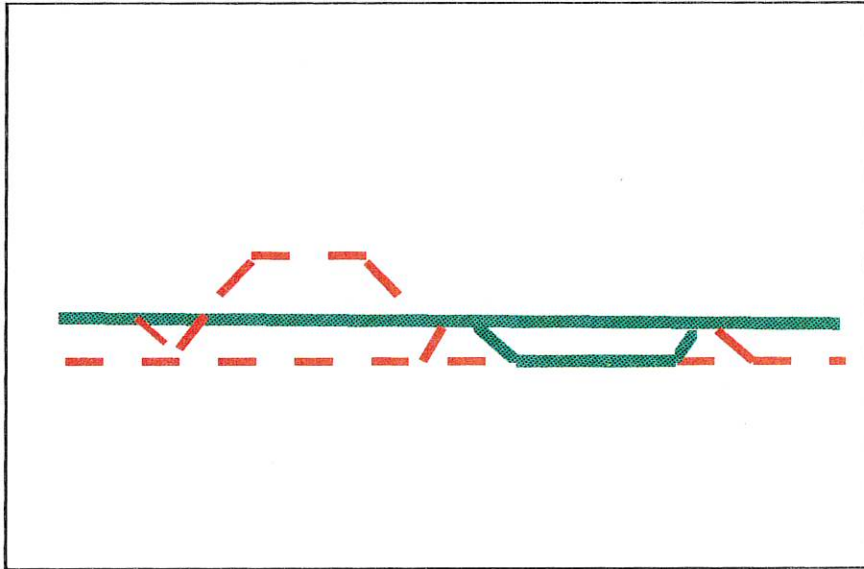
The policy varies significantly from one carrier to another. One key element is that passenger trains have priority over freight trains by statute, under the Rail

Passenger Service Act. All railroads profess to give passenger trains the priority, but it just doesn't always happen!

Statutory preference does not mean that passenger trains must always hold the main track at meeting points. On the contrary, in traffic control territory, the passenger train taking siding may expedite the meet and minimize delay to both trains.

One other delay category that never shows up as a delay is where the railroad has removed curve elevation or slowed the railroad down permanently often in violation of its contractual obligation. This delays each train over the route and the total impact may amount to thousands of minutes of delay each year.

Rationalization



Rationalization, a buzzword of the 80's and 90's, means reducing the physical plant to the maximum extent possible, often without regard to potential increases in traffic. It comes in two forms. The first is where mergers result in generally parallel routes. One is downgraded and the other becomes the primary line with resulting traffic increases. The second, which is actually more common, is where a conversion is made from two main tracks to single track. Sidings or main tracks are removed and the resulting plant has less capacity. The increase in traffic over the past three years has left many railroads scratching their heads about how to increase capacity quickly and economically. Some carriers with critical choke points are now hurting in trying to expedite freight traffic in addition to passenger trains. Threading a passenger train through congested areas is a difficult task.

Dispatching

Computer aided dispatching (should actually be known as dispatcher aided computers) permits the computer to dispatch trains -- just plug in the priorities and watch them roll, well sort of. The computer can make some bad decisions unless the dispatcher catches the error and overrides the decision. Some dispatchers' territories are analogous to the old television skit of the one-man cake factory where cakes spew off a conveyer belt until chaos reigns.

Software experts continually refine programs to correct situations where trains take siding with no train to meet -- known as meeting ghost trains -- or the local freight receives priority over the hottest trains on the division. The general explanation is, "We're working on it -- but we are not there yet." Conversely dispatchers can override the system and sometimes set up a situation that may negatively impact upon priority trains. It is a delicate balance.

Finally, you ask a logical question. If the train runs late every day why not add time to fix it. There are three basic reasons, known as Larson's Laws No. 16, No. 17, and No. 18.

- No. 16 - If there is excess time in the schedule the train dispatchers tend to take liberties with the trains.
- No. 17 - Station work tends to expand to fill all available time.
- No. 18 - If a train runs 30 minutes late each day and you add 30 minutes to the schedule, in 90 days it will be running 30 minutes late each day. You have to fix the basic problem.

You will recall that in my opening comments I said that a train with too much time in the schedule will run late. The reason for this is the first dispatcher will put the passenger train in the siding and advance a freight train, say 25 minutes as an example, using the rationale that there is an abundance of time in the schedule to make up the delay. The second dispatcher's rationale is "I got the train 25 minutes late and I delivered it 25 minutes late, I broke even with no delay to report." The third dispatcher says: "Damn, every day I get the train late and they expect me to make it up." And so the train runs late. We have actually improved performance by implementing faster schedules.

Finally, there is a concerted effort being made between the carriers and Amtrak to better control the delays that are controllable.

Scheduling Trains - A Summary

Scheduling has three basic components and an important secondary factor:

- **Pure Running Time**
- **Dwell Time**
- **Recovery Time**
- Passenger Train Meets

Once the above data is known:

- The schedule is strung.
- It is checked on a string graph.
- Connections are a critical part of scheduling.
- When delay time exceeds recovery time, the train is late.
- Delays are measured in broad categories:
 - Amtrak related delays
 - Freight related delays
 - Beyond control of either
- Passenger train meets

Remember, control is vested in the train dispatcher who governs priorities consistent with corporate policy - the dispatcher has the ultimate control.

- Once proposed schedules are developed they are negotiated with the freight railroads:
 - Schedule times
 - Length of schedules
- Schedules must be coordinated with commuter operations.
- Schedules impact upon the carriers' ability to earn millions of dollars in incentives.